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BULLETIN

OF THE

TORREY BOTANICAL CLUB

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TORREY BOTANICAL CLUB

DECEMBER, 1922

Miscellaneous notes on plants of Southern California—II*

PHILIP A. MUNZ AND IVAN M. JOHNSTON

LEMNA TRISULCA L.

Lemna trisulca L. Sp. Pl. 970. 1753.

This plant, reported by Abrams (Fl. Los Angeles 78. 1904) from Bear Valley in the San Bernardino Mountains and by Torrey (Pacific R. R. Rep. **4**: 142. 1856) from San Gabriel Creek, has been collected by Miss G. Corwin at the mouth of Santa Ana Canyon near Mentone, where it was found in a ditch at about 2000 feet altitude. It is, therefore, apparently to be looked for at various points along the Santa Ana River

MICROSTYLIS MONOPHYLLOS (L.) Lindl.

Ophrys monophyllos L. Sp. Pl. 947. 1753.
Microstylis monophyllos Lindl. Gen. Sp. Orch. 19. 1830.

A few typical specimens of this species, *F. W. Peirson 2271*, were collected in marshy ground at 8000 feet elevation on the South Fork of the Santa Ana River in the San Bernardino Mountains, where they grew with such plants as *Gentiana simplex*, *G. humilis*, *Parnassia cirrata*, and *Luzula comosa*. This is the first collection west of the Rocky Mountains.

Phoradendron californicum var. **distans** forma **leucocarpum** Trelease forma nova

Like the variety *distans*, but having white berries.

[The BULLETIN for November (**49**: 313–348) was issued November 9, 1922.

*The first paper of this series was published in the BULLETIN for February, 1922 (**49**: 31–44).

TYPE: Twenty-nine Palms, southern edge of Mohave Desert, May 1, 1921, *Munz 4550*, (Baker Herb. 9547).

Very conspicuous as white-fruited clumps growing in bushes of mesquite with the typical red-fruited form. Specimens of this collection were sent to Dr. Wm. Trelease who considered it worth recognition and permitted us to publish it. A second collection, *Munz 4703*, likewise on mesquite, from Andreas Canyon near Palm Springs, can also be reported.

Eriogonum nodosum var. **Jaegeri** var. nov.

With habit, inflorescence, and floral structures of the typical form of the species but with stems tomentose only below on the leaf-bearing portion, the upper parts of the stem and the inflorescence being glabrous with, at most, a little wool in the axils. Involucres glabrous or slightly floccose, the subtending bracts woolly on their inner edges.

TYPE: Dry Morongo Wash, near Hole-in-the-Wall Springs, Riverside County, November 15, 1921, *E. C. Jaeger 251* (Baker Herb. 9424).

This glabrate form of *E. nodosum* Small (Bull. Torrey Club **25**: 49. 1898) was collected at the eastern base of the San Bernardino Mountains, between 2500 and 3000 feet altitude, and well deserves recognition because of the totally different aspect as compared with the typical form. It is reported as very plentiful by its finder, Mr. Edmund C. Jaeger, one of the most active collectors of the desert flora.

Eriogonum fasciculatum var. **flavoviride** var. nov.

With capitate inflorescence and general habits of the var. *polifolium* T. & G., but lower in stature, about one foot high; light green in color instead of ashy; leaves glabrous and green above, but somewhat tomentose and pallid below; calyx glabrous without and hairy within.

TYPE: Pinyon Wells, southern edge of Mohave Desert, April 30, 1921, *Munz 4505*, (Baker Herb. 9425).

This peculiar yellowish green glabrate plant was found to be abundant in a sandy desert canyon in high Lower Sonoran Zone above Pinyon Wells. It was associated all along the canyon with var. *polifolium*, but was very distinct from this in size and color. We have seen also material from Cottonwood Pass, *Hall 6003*, about fifteen miles to the southeast and in the same general mountain range; here too it grew with var. *polifol-*

ium but was smaller and earlier in anthesis. The relation of this glabrous variety to var. *polifolium* is analogous to that existing between typical *E. fasciculatum* and the pubescent var. *foliolosum*.

ALLIONIA PUMILA Standley

Allionia pumila Standley, Contr. U. S. Nat. Herb. **12**: 345. 1909.
Allionia Brandegei Standley, *l. c.* 346.

The only *Allionia* hitherto reported from California is *A. Brandegei*, the type of which came from the Providence Mountains in the eastern part of the Mohave Desert. Two collections recently made by F. W. Peirson in the San Bernardino Mountains are of this species, which has recently been included in *A. pumila* by Standley (No. Am. Flora **21**: 226. 1918). These collections not only extend the range of this species to the western part of the desert but even into the coastal drainage. One (*Peirson 2257*) from the Santa Ana River, at 4500 feet elevation, is twice as tall as the type of *A. Brandegei* and has the leaves broadly ovate and cordate, rather than oblong and scarcely cordate. The other plant (*Peirson 1850*), from Cushenberry Grade, is more like Brandegee's type collection, being about ten inches high and with leaves ovate to oblong.

ALLIONIA NYCTAGINEA Michx.

Allionia nyctaginea Michx. Fl. Bor. Am. **1**: 100. 1803.
Allionia ovata Pursh, Fl. Am. Sept. 97. 1814.

The ovate-leaved form of the above species was found in June, 1919, to be locally established along a siding of the Santa Fe Railroad about a mile west of Upland, *Johnston 2169*. Examination of the locality in January, 1922, showed the colony to have been destroyed by the oil spray used by the railroad for weed destruction. This is apparently the first record for the state.

Scopulophila Rixfordii (Brandegee) comb. nov.

Achyronychia Rixfordii Brandegee, Zoe **1**: 230. 1890.
Scopulophila nitrophiloides Jones, Contr. W. Bot. **12**: 5. 1908.
Eremolithia Rixfordii Jepson, Fl. California 499. *f. 100*. 1914.

This odd desert plant seems to be generically distinct from *Achyronychia*, but Jones's *Scopulophila* has precedence over the much later generic name *Eremolithia* of Jepson.

Claytonia lanceolata var. **Peirsonii** var. nov.

As in the typical form of the species, but with peduncle and primary axis of inflorescence shortened so as to make the flowers appear umbellate.

TYPE: near Kelly's Cabin on Ontario Ridge, San Gabriel Mountains, at 8200 feet altitude, May 29, 1920, *F. W. & Mabel Peirson* (Baker Herb. 10524).

Known only from the eastern portion of the San Gabriel Mountains where, beside the type, we have seen a collection, *F. W. Peirson 2151*, from the Devil's Backbone at 7000 feet altitude. It is probable that this variety will necessitate a reconsideration of the status of *C. umbellata* Wats. (Bot. King Exp. 43. *pl. 6, f. 4–5*. 1871) of the northeastern part of California, for the principal character of that species is the same umbellate inflorescence that characterizes our variety. The new variety, however, may be told from *C. umbellata* by its shorter-petioled, broader leaves, which are widest below the middle (instead of above), and by its shorter stem, larger flowers, and isolated southern range.

THLASPI ARVENSE L.

Thlaspi arvense L. Sp. Pl. 646. 1753.

This crucifer, common in the Rocky Mountain region, can now be reported from Southern California (*F. W. Peirson 66*) at Henniger's Flats near Pasadena. The only other collection we have seen from California is by Chase from Adin, in Modoc County.

Draba corrugata var. **saxosa** (Davidson) comb. nov.

Draba saxosa Davidson, Bull. So. Cal. Acad. **19**: 11. 1920.

The phase of *Draba corrugata* that is found on San Jacinto Peak may well be deserving of a varietal name, but scarcely of a specific one. As pointed out in another paper (Johnston, Pl. World **22**: 88. 1919) the San Jacinto plant differs only in matters of degree and is closely simulated by some collections from the San Bernardino Mountains.

Sphaeralcea rosacea sp. nov.

A shrubby perennial forming loose clumps 10–15 dm. high; stems ashy, stellate-tomentose, slender, ascending, virgate; leaves remote, ovate- or oblong-cordate and somewhat three-lobed, doubly crenate, stellate-pubescent but greener above, blade usually 2–2.8 cm. long and 1.5–2.5 cm. wide, petioles 12–20 mm. long; inflorescence a very loose open panicle 2–4 dm. long, the ascending branches remote and one- to four-flowered; calyx stellate-tomentose, at anthesis 8–11 mm. high and 5–7 mm. wide, with lanceolate or oblong-lanceolate lobes, at fruiting 10–14 mm. long, bractlets setaceous, deciduous, 4–7 mm. long; pedicels 3–20 mm. long; petals pinkish when fresh but drying a rose-violet, 17–21 mm. long, claw densely villous-ciliate; fruit much depressed, stellate-pubescent; carpels one-seeded, about 3.5 mm. high, oblong in outline, sides smooth or at least not reticulate, seminiferous only below, the upper half thinner and scarious.

TYPE: Palm Springs, April 2, 1917, *Alice B. Chittenden* (Herb. Cal. Acad.).

A very ornamental species that is known to us only from the vicinity of Palm Springs, Riverside County, where it is a common plant in rocky ground in the canyons opening into the Colorado Desert. Besides the type we have seen a collection by Parish, No. 4109, and one by Johnston. This plant is the "purple-flowered form of *S. ambigua*," which is mentioned by Robinson (Synop. Fl. 1: 315. 1897) in his review of the genus. Though it has long passed as a form of *S. ambigua*, it is amply distinct and probably not even an immediate relative of that species, differing from it in habit and stature; in size, color and disposition of flowers; and in shape and texture of leaves. When we first saw the two species growing together, as they commonly do about Palm Springs, we never once thought of associating the two plants under one name; in fact, basing determination on superficial resemblances, the new species was taken to be a species of *Malvastrum*. The proposed species bears a considerable resemblance to certain of the shrubby malvastrums, having more or less woody stems and similarly colored flowers, but the technical characters of the carpels definitely ally it with *Sphaeralcea*.

VIOLA SHELTONI Torr.

Viola Sheltoni Torr. Pac. R. R. Rep. 4: 67. *pl. 2.* 1856.

Locally common on moist, shaded, oak-covered canyon-sides in the upper chaparral belt on the south slope of the San Antonio Mountains, where specimens have been collected in Charcoal Fork of Cucamonga Canyon, at 4200–4500 feet altitude, *Johnston 1303*, and near Brown's Flats, at 4200 feet, *Johnston 1759*. The specimens appear the same, character for character, as the common plant of Mendocino and Siskiyou Counties. The plant was known to range as far south as Mariposa County, where it was collected by Congdon, but between that station and the one in Southern California, which we now report, there lies a gap of over 280 miles in which the plant is not known to occur. This station for *V. Sheltoni* was announced as *V. lobata* by Johnston (Bull. So. Calif. Acad. **17**: 65. 1918).

OENOTHERA SPECIOSA Nutt.

Oenothera speciosa Nutt. Jour. Acad. Phila. **2**: 119. 1821.
Hartmannia speciosa Small, Bull. Torrey Club **23**: 181. 1896.

Well established along Chino Creek, from Pomona to near the confluence with the Santa Ana River. First collected several years ago by Johnston. Recently the following specimens have been collected near Pomona, all in moist soil along the stream: *Mrs. Lenington*, *Munz 4680*, *4560*. These discoveries add a new species and subgenus of *Oenothera* to the flora of California. Our material is atypical in its rounded instead of obcordate petals and in being taller, some of the specimens attaining a height of four feet.

Oenothera cardiophylla var. **splendens** var. nov.

A large flowered variation with hypanthium two-thirds as long as the capsule and 20–25 mm. long; petals 15 mm. long.

TYPE: high among rocks at the foot of The Needles, Colorado River, March 7, 1910, *Grinnell* (Univ. Calif. Herb. 196590).

A very remarkable variation of the species and, because of its large flowers, probably of ornamental value. We know of but two collections, the one from The Needles by Grinnell and the other from the Chocolate Mountains by Childs. The foliage and habit of the plant are those characteristic of the species. No doubt some will consider this distinct enough for a species, but we are deterred from publishing it as such because of the immense amount of variation in the floral structures of

typical *O. cardiophylla*, of which this seems only to be a remarkable extreme.

CHIMAPHILA UMBELLATA (L.) Nutt.

Pyrola umbellata L. Sp. Pl. 396. 1753.
Chimaphila umbellata Nutt. Gen. **1**: 274. 1818.
Chimaphila occidentalis Rydb. No. Am. Flora **29**: 30. 1914.

This species can now be reported from Southern California, having been collected in the Dollar Lake region of the San Bernardino Mountains at 8750 feet altitude, *F. W. Peirson 829*. This discovery and that of *Pyrola picta* Smith, *Johnston 2860*, add two species of Pyrolaceae to the list prepared by Parish (Pl. World **20**: 247. 1917) for the San Bernardino mountains.

Asclepias eriocarpa var. **microcarpa** var. nov.

Follicles 3–4 cm. long; seeds 5 mm. long; coma 15 mm. long; pedicels 2–3.5 cm . long; in flowers and vegetative parts like the typical form of the species.

TYPE: North Fork of Deep Creek, San Bernardino Mountains, on a sunny hillside at 6000 feet altitude, July 17, 1921, *I. M. Johnston 2833* (Baker Herb. 9563.)

This variety is the form of the species frequent through the pine belt of the San Bernardino Mountains and differs from the typical form, which is not uncommon on the plains at the foot of the mountains, in its much smaller follicles. Many plants of the valley-inhabiting *A. eriocarpa* Benth. have been seen by the authors, but none have been noted which failed to have fruit much larger than in the variety here described. *A. eriocarpa* has follicles 8–10 cm. long on pedicels 4–6 cm. long, while the seeds measure about 8 mm. in length and have a coma 24 mm. long.

The small follicles can not be attributed to the blighting action of frost, for all produce perfect seeds and in all colonies seen the fruit was uniform in size and as here described. Further exploration may reveal the fact that the pine-belt form of *A. eriocarpa* found in the San Jacinto and San Gabriel Mountains is also referable to this variety; fruiting material from these ranges is lacking.

Phlox bernardina sp. nov.

Phlox dolichantha Brand; Engler, Pflanzenreich 4[250]: 67. *f. 18, A-D.* 1907; Nels. W. Am. Phloxes 28. 1898; Milliken, Univ. Cal. Pub. Bot. **2**: 65. 1904. Not *P. dolichantha* Gray, Proc. Am. Acad. **22**: 310. 1887.

TYPE: in open pine forest, 6000 feet altitude, Bear Valley, June 1886, *Parish 1818*, (Univ. Calif. Herb. 194015).

The new species indicated here is the plant from the San Bernardino Mountains that has been known as *P. dolicantha*. The type of *P. dolichantha* Gray, however, came from the Pahrangat Mountains in southern Nevada and is evidently a form of what has been called *P. Stansburyi brevifolia* and *P. superba*. In the recent treatments of *Phlox* by E. Nelson, Milliken, and Brand, the plant from the San Bernardino Mountains has usurped the name of *P. dolichantha* to the exclusion of the original Nevada plants. *P. bernardina* differs from *P. dolichantha* and its immediate relatives in its very elongated corolla-tube, which is over four, instead of less than three, times the length of the calyx; in having its stems not shrubby below but herbaceous to the ground; and in its habitat, which is not at low altitudes in desert mountains but in the open pine forests of the San Bernardino Mountains. The new species is separated from its nearest relative by over 100 miles. It is known only from San Bernardino Mountains and appears to have been collected there in Bear Valley only.

NAMA HUMIFUSUM Brand

Nama humifusum Brand, Beiträge Hydrophyll. 9. 1911.

In Southern California this species has been known only from the three localities (Soldiers' Home, Los Angeles County, and Diamond Lake and Sweetwater Valley in San Diego County) given by Brand in the Pflanzenreich (4[251]: 146. 1913); the plant, however, may be reported from Laguna Canyon in Orange County, where it was collected in May, 1919, *Munz, Street, & Williams 2681*.

LYCIUM SPENCERAE Macbride

Lycium Spencerae Macbride, Contr. Gray Herb. 53: 18. 1918.

The type of this species proves to be a flowering specimen of *Prunus fasciculata* (Torr.) Gray (Proc. Am. Acad. **10**: 70.

1874). The identifying of this lycioid almond with *L. Spencerae* adjusts for local botanists the problem of explaining how so distinct a species, as this *Lycium* seemed to be, could so long go undetected in a locality so frequently visited as Cajon Pass. We are under obligations to Mr. F. Macbride for making at the Gray Herbarium the comparisons necessary for the establishing of the identity of the two species.

Penstemon Clevelandi var. **connatus** var. nov.

With habit of growth and flowers of the species, but with leaves jagged-serrate, usually glabrous and with at least the four upper pairs connate-perfoliate.

TYPE: near Van Deventers, southeastern base of the San Jacinto Mountains, June 1901, *H. M. Hall 2149* (Univ. Calif. Herb. 54999).

A very well marked variation that is apparently restricted to the eastern (Colorado Desert) base of the San Jacinto Mountains. Referable to this variety are the following: *Hall 1160* from the type locality, *Parish Bros. 1216* and *Johnston*, April, 1917, from near Palm Springs. The most evident relationship is with the variety *Stephensi* of the eastern Mohave Desert, the new variety agreeing in its foliar characters but differing in its somewhat smaller corolla and beardless sterile stamens. In our recent discussion of the var. *Stephensi* (Bull. Torrey Club **46**: 41. 1922) the specimens of *P. Clevelandi* Gray mentioned as simulating that variety in habit are in fact referable to var. *connatus*.

P. Clevelandi in its typical form occurs along the desert borders to the south of the range of the var. *connatus*. The northernmost locality seen for it is Coyote Canyon, *Hall 2766*. In the typical form the leaves are entire or rarely remotely dentate, never glaucous and are entirely free or, at most, only partially joined and not completely fused, with the suture line obliterated as in the variety.

Galium angustifolium var. **pinetorum** var. nov.

A low herbaceous perennial, stems 2–4 dm. high, simple, erect, tufted or arising from along short, prostrate, persistent, subterranean stems.

TYPE: Sierra Madre Mountains, Los Angeles County, 1893, *A. Davidson* (Univ. Calif. Herb. 28169).

A variety of the pine-belt and differing from the typical form of the species only in habit of growth. Additional specimens referable to this variety are the following: Santa Lucia Mountains, *K. Brandegee*, on the north, and Cuyamaca Mountains, *T. S. Brandegee*, July 7, 1894, on the south. Plants from the San Jacinto Mountains, *Hall 2509*, have the growth-habit of the variety, but are strictly branched and become 5–7 dm. high. The variety has been mentioned without a formal name by Johnston (Pl. World **22**: 118. 1919).

Galium Hallii sp. nov.

Dioecious perennial, shrubby at the base, with relatively few long (4–6 dm.) decumbent quadrangular stems, younger stems short-hispid, older stems glabrate and with a shiny exfoliating papery bark; leaves in fours, hirsute like the branchlets, light green, ovate-elliptical to elliptical, 5–11 mm. long, sessile, margins strongly revolute, midvein strong, lateral veins weak or absent; flowers borne in loose leafy clusters on the conspicuously and gracefully recurved tips of the branchlets, yellowish, about 2 mm. in diameter, bearing a few stiff hairs; fruit black, slightly juicy, body 3 mm. in diameter, covered with dense villous hairs of 2 mm. length.

TYPE: Coldwater Fork of Lytle Creek, San Gabriel Mountains, in gravelly ground at 5200–5700 feet altitude, July 7, 1918, *Johnston 2067* (Univ. Calif. Herb.).

Specimens examined: Coldwater Fork of Lytle Creek, San Gabriel Mountains, 5500 ft. alt. *Johnston 1667;* Lytle Creek, 5750 ft. alt., *Hall 1227;* Rock Creek Canyon, San Gabriel Mountains, *Abrams & McGregor 598;* Seymour Creek, Mt. Pinos region, 6700 ft. alt., *Hall 6505;* Tehachepi, 1889, *Greene;* Erskin Creek, 4–5000 ft. alt., *Purpus 5349*.

This is a remarkably clear-cut undescribed species of the *G. multiflorum*-alliance that has been confused with *G. multiflorum*, *G. stellatum*, and *G. occidentale;* from all of these it certainly differs and can be distinguished by its nodding flower-clusters. The plant has been recognized as distinct for several years, and the increasing material at hand seems to justify its description as a new species. It has been treated as "*Galium* sp." by Johnston (Pl. World **22**: 118. 1919).

The range is eminently a natural one, for the plant occurs at and just below the lower limits of the pine belt in the rocky canyons that open into the extreme western portion of the Mohave

Desert. The type locality, the southernmost known station, is almost on the Los Angeles—San Bernardino County line; from this point the range extends northward to Erskin Creek in the Sierra Nevada of Kern County.

It might be mentioned here that *G. occidentale* McClatchie (Erythea **2**: 124. 1894) is a trivial form of *G. californicum* H. & A., and that *G. grande* McClatchie (*l. c.*) is indistinguishable from *G. pubens* Gray. These identities are established by a study of authentic specimens.

BAHIA DISSECTA (Gray) Britton

Amauria dissecta Gray, Mem. Am. Acad. II. **4**: 104. 1849.
Bahia dissecta Britton, Trans. N. Y. Acad. Sci. **8**: 68. 1888.
Villanova dissecta Rydb. Bull. Torrey Club **37**: 333. 1910.
Amauriopsis dissecta Rydb. No. Am. Flora **34**: 37. 1914.

The first collection of this species to be reported from the state was made in the San Bernardino Mountains, *F. W. Peirson 2245*, along the Santa Ana River, at 6500 feet elevation, August 24, 1920.

POMONA COLLEGE
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Notes on Carex—XII

KENNETH KENT MACKENZIE

1. AN INLAND RELATIVE OF A SALT MARSH SEDGE

The only representative of the *Ovales* which is an inhabitant of salt marshes, as far as I am aware. is *Carex hormathodes* Fernald, which is an abundant and characteristic species along the North American coasts from western Newfoundland to southeastern Virginia.* In 1902 attention was first drawn by Professor Fernald to an allied pla ıt found in fresh water swamps and reported by him as growing from Massachusetts to the District of Columbia. This was first treated by him as *Carex tenera* Dewey var. *Richii* Fernald, and later on as *Carex hormathodes* var. *Richii* Fernald.

In northern New Jersey this variety *Richii* is an abundant plant in places in swampy meadows, and with its graceful nodding heads is one of the most pleasing and attractive of our sedges. It is in every way a much more handsome plant than is *Carex hormathodes*. But not only does it have an entirely different habitat and a different appearance, but it has technical characters which are absolutely good. The perigynia have suborbicular bodies abruptly contracted into the beaks; the perigynia are loosely ascending or spreading in the spikes; the terminal spike is abruptly contracted at base below the perigynia, and the staminate portion is conspicuous; and the spikes are scattered in a very flexuous head. In *Carex hormathodes* on the other hand the perigynia have oblong-ovate bodies much less abruptly contracted into the beaks; the perigynia are appressed; the terminal spike tapers at base, and the staminate portion is short; and the upper spikes are approximate. The

* The inland reports for this species are all erroneous, as also are the reports of its occurrence from further south than southeastern Virginia. It however is to be expected at least as far south as North Carolina. The var. *invisa* (Boott) Fernald represents nothing but stunted specimens.

differences between the two species are well brought out in the figures (No. 356–8) in Gray's Manual.

In proposing specific rank for this plant I am glad to say that I have the cordial support of Professor Fernald and Mr. Bayard Long, both of whom are well acquinted with it in the field.

Carex Richii (Fernald) Mackenzie sp. nov.

Carex tenera Dewey var. *major* Olney, Exsicc. fasc. 2, No. 15 (in part). 1870.

Carex tenera var. *Richii* Fernald, Proc. Am. Acad. **37**: 475. 1902.

Carex hormathodes Fernald var. *Richii* Fernald, Rhodora **8**: 166. 1906.

Densely cespitose, the rootstocks very short-prolonged, black, fibrillose, the culms 6–10 dm. high, erect, but very slender to base, nodding, sharply triangular, very rough beneath head, exceeding the leaves, dark brownish at base and clothed with the dried-up leaves of the previous year, the lower bladeless; leaves of the year two to four to a culm, on lower fourth, but widely separate, the lower nodes often exposed, the blades flat, 1.5–2.5 mm. wide, usually 1–3 dm. long, long-attenuate, the sheaths green striate ventrally nearly to mouth, the ligule surrounding the culm, short-prolonged beyond base of blade; spikes four to eight, strongly separate in a moniliform, flexuous head, gynaecandrous, the staminate flowers conspicuous, tapering clavate or in the terminal truncate clavate at base, the pistillate part orbicular to ovoid-orbiculur, 6–12 mm. long, 6–9 mm. wide, rounded at apex, and with some twenty to thirty spreading or spreading-ascending perigynia with conspicuous tips; lower bracts setaceous, prolonged, the upper scale-like; scales lanceolate, hyaline and yellowish-brown tinged, acuminate or aristate from the sharp midvein, shorter and much narrower than the perigynia; perigynia very flat and thin except where distended by achene, membranceous, greenish, or in age straw-colored, 4–5 mm. long, 2.5 mm. wide, the body suborbicular, widest near middle, strongly winged to base, serrulate above middle, finely about 10-nerved on either side, round-truncate and sessile at base, abruptly contracted into the flat, serrulate, red-tipped, obliquely cut dorsally at length bidentate beak, more than half length of body; achenes lenticular, stipitate, oblong-obovoid, 1.5 mm. long, 0.75 mm. wide, yellowish-brown, apiculate; style slender, obscurely jointed with achene; stigmas two, reddish, slender, short.

SPECIMENS EXAMINED*

MASSACHUSETTS: Middleboro, *Murdoch*, June, 1900 (N.E.) Canton, *Churchill*, June 17, 1900 (N.E.); Dover, *Winslow*, June 21, 1912 (N.E.); Dedham, *Forbes*, June 10, 1912 (N.E.); Stony Brook Reservation, *Kidder*, June 14, 1920 (N.E.); Sudbury, *Rich et al. 99* (TYPE), June 17, 1902 (N.E., H., P., N. Y., K.M.); Bedford, *Murdoch*, June 7, 1902 (N.E.); Weston, *Weatherby*, June 20, 1909 (N.E.); West Cambridge, *Pease 3084*, May 27, 1903 (N.E.); South Sudbury, *Miss Carr*, June 30, 1897 (N.E.); Cambridge, *Beal* (H.), also *Hubbard*, June 2, 1896 (N. E.), also *Deane*, June 8, 1887 (H.), also *Fernald*, June 10, 1891 (Col.); Stoneham, *Rich*, June 5, 1894 (N.E.); Reading, *Perkins*, June 14, 1883 (N.E.), also *Manning*, June 8, 1882 (N.E.); Arlington, *Wm. Boott*, June 5, 1870 (H.); Mystic Pond, *Wm. Boott*. June 5, 1870 (H.); Amesbury, *Eaton*, June 1, 1903 (H.); Sherborn, *Loomis 1033*, June 19, 1912 (K.M.).

RHODE ISLAND: Providence, *Olney* (N.Y.).

CONNECTICUT: Waterbury, *Blewitt*, June 15, 1911 (N.E.), also *1287*, June 10, 1912 (N.E.); South Windsor, *Woodward*, June 28, 1909 (N.E.); Columbia, *Weatherby 4090*, June 26, 1917 (N.E.); Thompson, *Weatherby 4114*, July 1, 1917 (N.E.); Pomfret, June 5, 1871 (N.Y.); Newington, *Wright*, May, 1879 (H.); Sprague, *Graves*, June 13, 1902 (H.); Griswold, *Graves*, June 16, 1899 (H.); Killingly, *Bissell*, June 22, 1902 (H.); Thompson, *Bissell*, June 22, 1902 (H.); Oxford, *Harger*, June 5, 1904 (H.), also *4262*, June 11, 1905 (P.); East Hartford, *Weatherby*, May 25, 1903 (H.); Milford, *Eames 5120*, June 24, 1904 (K. M., H.);

NEW YORK: Junius, *Sartwell* (H.).

NEW JERSEY: Closter, *Austin* (H.); Newark, *Livingston 35*, May 27, 1894 (H.); Crosswick's Creek, *Britton*, May 29, 1904 (N. Y.); Passaic River, Bergen County (N.Y.); Oradell, Bergen County, *Mackenzie 759*, June 19, 1904 (K.M.); Stirlington, Morris County, *Mackenzie 1267*, May 28, 1905 (K.M.); Mon-

*Specimens are cited from herbaria as follows: Columbia University (Col.); Gray Herbarium, Harvard University (H.); K. K. Mackenzie (K.M); New England Botanical Club (N.E); New York Botanical Garden (N.Y.); New York State Museum (Albany); Philadelphia Academy of Natural Sciences (P.).

mouth Junction, *Mackenzie 4963*, May 26, 1912 (K.M.); Succasunna, *Mackenzie 4128*, June 13, 1909 (K.M.); Delanco, Burlington County, *Long 3474*, May 19, 1910 (P.); Centre Square, *Brinton*, May 20, 1892 (P.); eight miles southwest of Mickleton, *Heritage*, May 25, 1892 (P.); Budd's Lake, Morris County, *Heritage*, May 28, 1895 (P.).

PENNSYLVANIA: Easton, *Garber*, 1868 (P.), also *Porter*, June 5, 1890 (P.); Lehigh Gap, Lehigh County, *Pretz 1831*, May 20, 1909 (P.); Slatington, Lehigh County, *Pretz 10182*, June 6, 1920 (P.), also *Bachman 2132*, June 1, 1911 (P.); Strassburg, Lehigh County, *Pretz 3355*, May 20, 1911 (P.); Cementon, Lehigh County, *Pretz 10131*, May 30, 1920 (P.); Rockhill, *MacElwee*, May 31, 1903 (P.); Quakertown, Bucks County, *Martindale* (P.); Sellersville, *Pretz*, May 25, 1884, June 1, 1888, and May 26, 1896 (P.), also *Crawford*, June 1, 1989 (P).; Penn Valley, Bucks County, *Crawford*, June 1, 1899 (P.); Tullytown, *Crawford & Brown*, 1902 (P.); Byberry, *Martindale*, June, 1864 (P.); Wissahickon, *A. H. Smith* (P.); Sugartown, Chester County, *Pennell & Long 7628*, June 26, 1912 (P.); Nottingham, Chester County, *Pennell & Long 7483*, June 22, 1912 (P.); Mercersburg, Franklin County, *ex herb. Porter*, May 25, 1847 (P.); Wyoming Valley, *Thurston*, 1892 (P.); Elk County, *McMinn*, 1868 (P.).

DELAWARE: Wilmington, *Commons*, June 30, 1896 (P.); Vandyke, Newcastle County, *Long* May 24, 1909 (P.); Townsend, *Commons*, May 17, 1883 (P.).

INDIANA: Palmyra, Harrison County, *Deam 23417*, June 4, 1917 (K.M., H).

2. A SEGREGATE FROM CAREX ALBOLUTESCENS

Among the varieties of *Carex straminea* Willd. recognized by Professor Bailey was var. *cumulata* Bailey, based on specimens collected in Pennsylvania by Porter, in New Brunswick by Fowler and on the Saskatchewan Plains by Macoun. This variety, proposed in 1889, was maintained by Bailey in 1890 in the 6th Edition of Gray's Manual (p. 622), where its distribution was given as from Pennsylvania to New England and northward. It was said to be rare and to grow in dry grounds. Three years later in 1893 Professor Bailey placed the plant under *Carex albolutescens* Schw., as a variety, but added noth-

ing to his previous publications concerning its distinguishing characters or range; and this treatment is followed by Kükenthal in the Pflanzenreich (4[20]: 209). By other authors Professor Bailey's name has been treated as a synonym of *Carex albolutescens*.*

As shown however by the large number of specimens of Bailey's variety which have been collected in recent years, it not only has an entirely different range from *Carex albolutescens* but it has several constant and well-marked points of difference, and is clearly entitled to specific rank. It is a northern species ranging from Saskatchewan to New Brunswick and south to Massachusetts, Connecticut and northern Pennsylvania. It occurs in a great variety of habitats varying from wet to dry, but seems able to thrive in much drier places than can *Carex albolutescens*. In the southern part of its range it seems only to be recorded from the higher elevations. It is not a coastal plain plant like *Carex albolutescens*, but like that species is not a species of limestone areas.

As above stated *Carex albolutescens* is typically a coastal plant. It reaches its northern limit in eastern Massachusetts but has a very extensive range to the south, being found as far south as northern South America. In the more southern part of its range it gets into the mountains.

The best technical character to separate the northern plant from *Carex albolutescens* is that in it the perigynia are nerveless ventrally, while in *Carex albolutescens* they are strongly several-nerved. But in addition to this the spikes are numerous (five to thirty) and densely aggregated; the green perigynia are more conspicuous than in *Carex albolutescens*, thus giving the heads a characteristic heavy, green, or in age brownish, appearance; the sheaths are looser, and the leaf-blades of the sterile culms are usually wider, being 4–5 mm. in width; in developed plants the lateral spikes also are truncate-rounded at base.

Carex albolutescens has fewer spikes (three to ten), which are less densely aggregated; and the heads have a very characteristic silvery-green appearance; its sheaths are tighter than in the northern plant and the leaf-blades of the sterile culms are

* The perigynium and the heavily spiked head, figured in the seventh edition of Gray's Manual (*f. 351*) as *Carex albolutescens*, represent Bailey's plant, and the head with five spikes represents genuine *Carex albolutescens*.

normally narrower and but 2.5–3 mm. in width (although occasionally more); and the lateral spikes are round-tapering at base.

The northern plant is evidently abundantly distinct and it should be treated as

Carex cumulata (Bailey) Mackenzie sp. nov.

Carex alata Torr. var. *pulchra* Olney (mostly), Exsicc. fasc. 2, No. 23 (also Bailey Proc. Am. Acad. **22**: 150 as synonym). 1871.

Carex straminea Willd. var. *cumulata* Bailey, Mem. Torrey Club **1**: 23. 1889.

Carex albolutescens Schw. var. *cumulata* Bailey, Bull. Torrey Club **20**: 422. 1893.

Very densely cespitose, the rootstock not prolonged, the culms 3–9 dm. high, stiff, sharply triangular, roughened beneath head, brownish at base and clothed with the dried-up leaves of the previous year, the lowest bladeless; leaves of the year with well-developed blades two to four to a culm, on lower third but not bunched, the lower nodes sometimes exposed, the blades flat, light-green, thickish, erect or ascending, 3–5 mm. wide, 7–25 cm. long, roughened towards apex, the sheaths loose, strongly green striate ventrally and conspicuously prolonged beyond base of blade and continuous with the ligule; sterile shoots elongated, the blades usually 4–5 mm. wide, occasionally narrower, erect, the sheaths very loose; spikes five to thirty, gynaecandrous, very closely aggregated into an ovoid or oblong head 2–4 cm. long, 1–2 cm. thick, the spikes ovoid, 6–10 mm. long, 5–8 mm. thick, short-pointed at apex, the lateral truncate or rounded at base, the terminal clavate, greenish appearing or in age brownish, closely many-flowered, the perigynia ascending with appressed green tips; lowest bract cuspidate prolonged, often conspicuous; scales ovate, obtuse or acute, much narrower and shorter than the perigynia, white-hyaline with one- to three-nerved green center; perigynia thin, plano-convex, 3–4 mm. long, 2.5 mm. wide, membranaceous, greenish or in age brownish, the body orbicular-obovate, widest at top, round-tapering and sessile at base, wing-margined nearly to base, serrulate above the middle, nerveless ventrally, lightly several-nerved dorsally, very abruptly contracted into the short, serrulate, flat, obliquely cut dorsally beak about 0.75 mm. long, about one-third to one-fourth the length of the body; achenes lenticular, oval-obovoid, at maturity yellowish brown, very short substipitate, 2 mm. long, 1.25 mm. wide, bent-apiculate; style slender,

jointed with achene, at length deciduous; stigmas two, slender, light-reddish, short.

SPECIMENS EXAMINED

NEW BRUNSWICK: Bass River, *Fowler*, August 9, 1872 (H, N.Y.); Miramichi, *Fowler*, August 24, 1894 (H.), also *Williams & Fernald*, July 25, 1902 (H.); Kent County, *Fowler* (TYPE), July 1870 (H., N.Y., Col. Albany, P.).

NOVA SCOTIA: Bell's Island, Lahave River, *Macoun 82518*, August 10, 1910 (H.); Bridgewater, *Macoun 82519*, July 18, 1910 (H.); Springhill Junction, *Pease & Long 20309*, July 18, 1920 (K.M.); Port Mouton, *Fernald & Graves 20312*, August 18, 1920 (K.M.); Middleton, *Fernald et al. 20325*, July 20, 1920 (K. M.); Broad River, *Fernald & Bissell 20311*, August 16, 1920 (K.M.).

MAINE: Somesville, *Fernald*, September 22, 1892 (N.E.,H.); Bangor, *Knight*, August 7, 1904 (H.); Pembroke, *Fernald 1439*, July 17, 1909, (N.E., H.); Southport, *Fernald*, August 1 and 2, 1894, (N.E., H); Kennebunk, *Parlin 867*, August 26, 1897 (H., N.E.); Mt. Desert Island, *Greenleaf*, August 3, 1883 (N.E.), also *Rand*, *Redfield*, *Faxon*, *Fernald*, *Williams*, numerous collections 1890–1898 (H., N.E., Col., N.Y.); Milford, *Fernald & Long 12928*, August 25, 1916 (N.E.); Lovell, *Pease 17307*, August 30, 1918 (N.E.); Matinicus, *C. A. E. Long*, August 28, 1919 (N. E.); summit of Mt. Battie, 1325 feet, *Furbish*, July 14, 1903 (N.E.), also *Bissell*, August 13, 1913 (N.E.); Durham, *Dinsmore*, August, 1898 (N.E.); Bear Mountain, Livermore, *Furbish*, July 24 and 25, 1896 (N.E.); Kennebunk, *Deane*, July 5, 1894 (N.E.); Berwick, *Parlin 1062*, July 24, 1898 (N.E.); North Berwick, *Fernald*, July, 1897 (N.E.).

NEW HAMPSHIRE: Nottingham, *Eaton*, June 20, 1900 (H.); Mt. Monadnock, 3000 ft., *Harper*, July 3, 1899 (N.E.), also "*A. W. D.*," August 7, 1916 (N.E.).

MASSACHUSETTS: Mt. Watatic, Ashby, *Knowlton*, August 9, 1908 (H.); Medford, *W. Boott*, June 30, 1861, (N.E.); July 25, 1863 (H.); Edgewith, *W. Boott*, July, 1853 (H.); Ashland, *Morong*, July 10, 1879 (H.); West Manchester, *Hubbard 195*, October 11, 1911 (N.E.); Middlesex Falls, *Kidder*, June 28, 1920 (N.E.); Wilmington, *Collins*, June 25, 1887 (N.E.); Mt. Washington, Berkshire County, *Hoffman*, August 23, 1914

(N.E.); Lake Undine Dome, Berkshire county, *Hoffman*, August 27, 1902 (N. E.).

CONNECTICUT: East Windsor Hill, "*A. W. D.*", August 26, 1915 (N.E.); South Windsor, *Bissell*, July 30, 1916 (N.E.); also *Blewitt 1502*, July 10, 1912 (N.E.), also *3470*, August 8, 1917 (P.).

NEW YORK: Taghkanick Range, *Hoysradt*, July-August (H.); Karner, Albany County, *House, 6410*, July 7, 1919 (Albany); Whitestown, Oneida County, *Haberer 3760*, August 22, 1912 (Albany); Ft. Ann, Washington County, *Burnham 49*, June 19, 1892 (N.Y.); Sams Point, alt. 2600 ft., *Rusby*, August 20, 1896 (Col.); Mt. Riga, *Hoysradt*, July 17, 1878 (Col.).

PENNSYLVANIA: Naomi Pines, *Porter*, July 1, 1893 (P.), also *Britton*, July 2, 1893 (Col.); Pocono Plateau, *T. Greene*, September 4, 1861 (P.), also *Porter*, September 11, 1869 (P.), July 25, 1881 (P.), August 6, 1891 (Col., H.), and July 1, 1893 (P.).

MICHIGAN: Alger, *Wheeler*, July 2, 1895 (H.); Omer, Arenac County, *Wheeler*, July 24, 1902 (H.); Duck Lake, Arenac County, *Wheeler*, 1900 (H.); Township 18, n. 4 E., Section 24, *Wheeler*, August 8, 1900 (H.); Township 19, n. 6 E., Section 16, *Wheeler*, August 9, 1900 (H.); Emerson, Chippewa County, *Dodge*, August 28 and September 4, 1914, (K.M.); Manistique, Schoolcraft County, *Dodge*, September 22, 1915 (K.M.); Alpena, *Wheeler*, July 8, 1895 (H., Col.).

ONTARIO: Lake of the Woods, *Macoun 33*, July 28, 1872 (H.).

SASKATCHEWAN: Fort Ellice, *Macoun 219*, 1872 (H.).

3. A NORTHERN RELATIVE OF CAREX BREVIOR

In the northern part of the United States from Maine to Michigan and in southern Canada from Ontario to Manitoba, there is found a large, robust and handsome member of the *Ovales*. It has five to ten spikes, which normally are well separated, but plants with approximate or subapproximate spikes are not uncommon. It is the plant treated by Professor Fernald as *Carex festucacea* Schk. (Proc. Am. Acad. **37**: 477. *pl. 3, f. 47–48*), and also so treated in Gray's Manual (7th ed., p. 221. *f. 363*). To it is added in the treatments referred to a variety *brevior* (Dewey) Fernald, distinguished by having but three to six approximate or subapproximate spikes.

When I prepared the article on *Carex* for the second edition of Britton & Brown's Illustrated Flora, I treated these two plants together, because the number of heads and their degree of separation was not a constant character. Later, in a paper on *Carex straminea* and its allies (Bull. Torrey Club **42**: 603. 1916), it was pointed out that the genuine *Carex festucacea* was a different plant than either of the above, and the name *Carex brevior* (Dewey) Mackenzie was applied to what I had treated as *Carex festucacea* Schk. in the Illustrated Flora.

In the meantime Kükenthal (Pflanzenreich 4^{20}: 207), noticing the close general resemblance of Fernald's *Carex festucacea* to *Carex Bicknellii* Britton (*Carex straminea* var. *Crawei* Boott), cited it under his treatment of that plant.

A detailed study has disclosed that the large northern plant here under discussion has characters which are constant in a very considerable series of specimens. As compared with *Carex brevior* it has the perigynia appressed-erect instead of spreading-ascending. The mature perigynia are membranaceous and strongly pellucid-puncticulate. They entirely lack the firm coriaceous texture so characteristic of *Carex brevior* and are also more nerved than in that species. These differences are well brought out in Fernald's figures above referred to, even the difference in the texture of the perigynia coming out.

The culms of the northern plant are much developed the first year of their growth, and the old dried leaves towards the base of the culm are therefore very marked in the flowering year. In *Carex brevior* on the other hand the development the first year is much less, and the dried leaves are short and rather inconspicuous in the flowering year. The sheaths too in the northern plant are white-hyaline ventrally for but a short distance, while in *Carex brevior* this feature is very strongly developed, and they also differ from those of the latter plant in being strongly papillate dorsally. As stated by Fernald the northern plant has five to ten spikes which normally are distinct and well separate, and *Carex brevior* usually has fewer spikes which are approximate or sub-approximate. However, this is but a well-marked tendency and specimens of the northern plant with a congested head or *Carex brevior* with spikes as widely separated as in the northern plant are not uncommon. *Carex Bicknellii* can be readily distinguished by its larger

(5.5–7.5 mm. long), nearly translucent perigynia, which are strongly about ten-nerved ventrally, and very strongly winged. It is, I would say, more closely related to the northern plant than is *Carex brevior*.

A real understanding of the members of the *Ovales* found in the northeastern part of North America and the characters which separate them dates from Professor Fernald's revision of the group in 1902. The plant which I have been here discussing is one which he has collected on a number of occasions. It is therefore one to which it is highly fitting to give his name. Unfortunately there is a poorly understood Japanese species to which his name has been given. Under the circumstances I trust that I will be pardoned in proposing for the plant I have been discussing a longer name than would ordinarily be desirable.

Carex Merritt-Fernaldii Mackenzie sp. nov.

"*Carex festucacea* Schkuhr" Fernald, Proc. Am. Acad. 37: 477. *pl. 3, f. 47–8.* 1902.

Cespitose from short-prolonged, lignescent, black-fibrillose rootstocks, the culms 3–10 dm. high, slender but stiff, sharply triangular above, terete towards base, strongly biennial, exceeding the leaves, smooth or very slightly roughened beneath head, conspicuously clothed at base with the short -bladed leaves of the previous year, the lower bladeless; leaves with well-developed blades three to six to a culm, on the lower third but not bunched, the blades erect-ascending, dull- or yellowish-green, firm, 1.5–3 mm. wide, usually 1–2 dm. long, strongly roughened towards apex especially on the margins, the sheaths tight, white-hyaline ventrally for a short distance below mouth only, strongly papillate dorsally, extending up beyond point of insertion of blade and continuous with ligule, the latter longer than wide; spikes four to ten (usually six to eight), aggregated to separate, the head 1.5–8 cm. long, 7–15 mm. wide, the spikes gynaecandrous, subglobose to ovoid, 7–15 mm. long, 5–9 mm. wide, with fifteen to thirty appressed-ascending perigynia above (the beaks appressed-ascending), blunt at apex, abruptly contracted into the short clavate basal staminate portion; bracts scale-like, the lowest often prolonged, 1–4 cm. long, the upper merely acuminate or short-awned; scales ovate, obtuse to short-cuspidate, yellowish brown with three-nerved green center and narrow hyaline margins, shorter and much narrower than the perigynia above; perigynia suborbicular, 4–5 mm. long, 2.5–3.5 mm. wide, concave-convex, thickish over the achene but the walls membran-

aceous, strongly pellucid-puncticulate, yellowish-green or in age yellowish-white, strongly winged to base, serrulate to below middle, truncate rounded at base, strongly several to many nerved dorsally, nerveless to three to five-nerved ventrally, often only towards base, the wings one- to two-nerved, abruptly narrowed into the flat, serrulate, reddish-brown tipped, obliquely cut dorsally, bidentate beak, about 1 mm. long and less than one-third length of body, the margins of the orifice reddish-brown; achenes lenticular, 1.75 mm. long, 1.5 mm. wide, substipitate, apiculate, brown, shining; style slender, straight, jointed with achene, deciduous; stigmas two, reddish brown, slender, long.

TYPE LOCALITY: Orono, Maine, *Fernald*, July 3, 1897 (TYPE in the Gray Herbarium of Harvard University).

SPECIMENS EXAMINED

MAINE: Seal Harbor, *Redfield*, July 14, 1890 (H., N.E., P.), also *Williams* July 25, 1890 (N.E); Canton, *Parlin 2021*, August 8, 1906 (H.); North Berwick, *Parlin 798*, July 15, 1897, also May 1892 (H.); Mt. Desert Island, *Rand*, July 9, 1893, also July 15, 1894 (H.); Basin Mills, *Knight*, July 15, 1904 (H.); Orono, *Fernald*, June 1, 1899 (N.E.), July 14, 1890 (N.E.), July 12, 1897 (N.E.), July 2 and 3, 1897 (H.); Bumford Point, *Parlin*, July 4, 1890 (H.); Canton, *Parlin* 1972, July 10, 1906 (H.), also *2275*, 1907 (H.); Tatnic, *Parlin*, July 11, 1891, also June 1892, (N. E., H.); Orono, *Fernald & Long 12953*, July 22, 1916; (N.E., P.); Milford, *Fernald & Long 12955*, August 25, 1916 (N.E., P.); Farmington, *Knowlton*, July 9, 1911 (N.E., P.); Woodstock, *Pease 17126*, July 11, 1918 (N.E.); Canton, *Parlin 2094*, June 25, 1907 (N.E.); Dixfield, *Parlin 2461*, June 28, 1908 (N.E.); Gilead, *Pease 16013*, July 5, 1914 (N.E.); Rumford Point, *Parlin*, July 4, 1890 (N.E.); Dennysville, *Fernald 1444*, July 19, 1909 (N.E.); Columbia, *Knowlton*, August 4, 1916 (N.E., P.); West Pembroke, *Fernald 1452*, July 6, 1909 (N.E.); Big Hill, *Fernald 1438*, July 17, 1909 (N.E.); Leeds, *Knowlton*, July 23, 1916, (N.E., P.); New Gloucester, *Knowlton*, July 25, 1920 (N.E.); Baldwin, *Fernald et al. 12956*, August 30, 1916 (N.E., P.); Kennebunkport, *Deane*, July 12, 1894 (N. E.); North Berwick, *Parlin 798*, July 15, 1897 (N.E.); Alfred, *Fernald & Long, 12954*, August 10, 1916 (N.E., P.); Wells, *Fernald & Long 12952*, August 8, 1916 (N.E., P.); North Ber-

wick, *Parlin & Fernald*, June 13–14, 1896 (N.E.); Tatnic Hill, *Parlin & Fernald*, June 13–14, 1896 (N.E.); Cape Porpoise, *Furbish*, July, 1901 (N.E.); South Berwick, Parlin, July 31, 1896 (N.E.); Hermon, *Knight* 5035, June 30, 1906 (K.M.); Veazie, *Knight*, July 15, 1905 (K.M.).

NEW HAMPSHIRE: Troy, *Rand & Robinson 507*, June 13, 1898 (H.); Shelburne, *Deane*, July 8, 1914, also July 30, 1914 (N.E., P.); Plymouth, *Fernald, 11589*, July 30, 1915 (N.E.); Durham, *Knowlton*, July 1, 1917 (P.).

VERMONT: Mason Hill, Pownal, *Churchill*, June 18, 1901 (N.E).

MASSACHUSETTS: Amherst, *B. P. Clark*, June 6, 1881 (P.).

NEW YORK: Wellesley Island, Jefferson County, *Robinson & Maxon 1*, June 28, 1902 (H.); Thousand Island Park, *Ball*, July 1904 (K.M.); Middle Grove, Saratoga County, *Peck* (Albany); East Galway, Saratoga County, *E. A. Burt* (Albany); West Ft. Ann, Washington County, *Burnham*, June 27, 1918 (Albany).

ONTARIO: Lake Nipigon, *John Macoun*, July 11, 1884 (H.); Kingston, *Klugh*, June 30, 1906 (H.); "Portage River, Lake Superior", *ex herb. C. E. Smith*, August 3, 1865 (P.).

MICHIGAN: Washington, *ex herb. Dewey;* Herb. (H.); Keweenaw County, *Farwell* 762, August 1890 (H.); Muskegon, *McClatchie 48* (H.); Douglas Lake, Emmet County, *Ehlers, 296, 299*, July 17, 1920, also *L. E. Smith 1*, July 3, 1917 and 159, Aug. 20, 1917(K.M.); Clifton, *Farwell*, July 18, 1890 (Albany); Isle Royale *Williamson, 2276* August 15, 1912 (P.).

MANITOBA: Lake Winnipeg Valley, *Bourgeau* 1857 (H.).

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ADDENDUM

After the above was written, and when on a visit to the Philadelphia Academy of Sciences, Mr. Bayard Long asked me to look at the type specimen of *Carex albolutescens* Schw. preserved there. It was apparent that it was a young and immature specimen of the genuine *Carex straminea* Schk. as interpreted by me (Bull. Torrey Club **42**: 605–6), a conclusion which Mr. Long had himself arrived at. The previous identification of the plant

of Schweinitz with the plant treated in this article and generally as *Carex albolutescens* can be readily understood. The two species really stand next to each other, and as long as genuine *Carex straminea* was not understood and kept separate, it was a natural thing to do to identify the plant of Schweinitz in the way that was done. The name, however, has always been inappropriate, and one is glad to be able to reduce it to synonymy.

It now appears that the plant treated in this article and generally as *Carex albolutescens* ("*Carex albolutescens* Schw." Kükenth. in Engler, Pflanzenreich **4**[20]: 208; Mackenzie in Britton & Brown, Ill. Fl. (2d. ed.) **1**: 385. *f. 941* [excluding var. *cumulata* Bailey]; Robinson & Fernald in A. Gray Man. (7th. ed.) 219. *pl. 351* [left hand] excluding var. *cumulata* Bailey; "*Carex foenea* Willd." Boott, Ill. Carex **3**: 118, *pl. 375*) is without a name. It therefore gives me much pleasure to be able to name it for that excellent field man and acute student, Mr. Bayard Long, as **Carex Longii**. A specimen collected July 24, 1907, by Mr. Long at Cold Spring, Cape May County, New Jersey, and preserved in the herbarium of the Philadelphia Academy of Natural Sciences is designated as the type.

Stimulation of plants by carbon disulphide

CARRIE OLDENBUSCH

The problem of stimulation of plants by minute doses of chemicals, which are poisonous in higher concentrations, has long been an interesting one. Raulin (**1**) in 1869 was probably the first to undertake work of this kind, using a nutrient solution made up of a large number of substances as a culture medium. As the stimulant, Raulin added to his nutrient solution small amounts of metallic salts, such as silver nitrate, platinum dichloride, or copper sulphate, and found that cultures of *Aspergillus niger*, grown in these solutions produced a more luxuriant mycelium than cultures to which nothing had been added. Pfeffer (**2**) in 1895, by means of comprehensive experiments, determined that such a complicated nutrient solution was unnecessary and originated a number of solutions which have been and are still extensively used in work of this kind. Benecke (**3**), in the same year, published a paper in which he also gave a much simpler normal solution than Raulin's but slightly different from Pfeffer's.

Richards (**4**), using the latter's solution with the addition of traces of zinc, iron, sodium, lithium, and other salts, obtained a heavier growth of *Aspergillus niger* and *Penicillium glaucum* than in cultures to which none of the above were added, demonstrating that Raulin's solutions really resulted in stimulation. Ono in 1900 corroborated Richards's results and also worked out the effect of these salts on certain algae. He found that algae as a rule have their point of greatest stimulation at a much lower concentration of the salt but in other respects are similar to fungi. Richards (**5**) and Ono (**6**) determined that the economic coefficient of sugar is considerably lower in the cultures to which salts had been added than in the controls, proving that stimulated fungi require a smaller amount of carbohydrate food in proportion to the quantity of waste acid produced.

Since this time many other investigators have worked on this problem, obtaining similar results. Kahlenberg and True (**7**) formulated a law which they gave as an explanation of this stimulation phenomenon. They claim that since the chemical and physical properties of solutions are due to the properties of

the ions dissociated in the solution and of the undissociated molecules, then the physiological properties of a solution are due to the same factors. The authors worked out this theory with lupine seeds, the germination of which was accelerated by dilute solutions of electrolytic salts. They claimed that this stimulation was due to the hydrogen and metallic ions in the solutions. Heald (**8**) working with seeds of other plants obtained similar results and also attributed them to the electrolytic dissociation. Stevens (**9**) working with fungus spores applies this same theory. Iwanoff (**10**) claims that metallic salts are poisonous to plants in proportion to the atomic weight of the metal, the heavier metals being more poisonous than those of smaller atomic weight. In his opinion, the same is true of the alcohols, the lower alcohols (methyl and ethyl) being less poisonous than those of higher molecular content, such as propyl and butyl. Steinberg (**11**), in a recent paper on the stimulation of *Aspergillus*, attributes the stimulation to the increase in H ion content when zinc salts are added to the nutrient solution. It is not obvious, however, that the action of such oligodynamic substances is due to the hydrogen ion concentration alone, especially since we find non-electrolytes, such as ether, chloroform, and other anaesthetics, exerting a stimulatory influence. Carbon disulphide, being a very volatile liquid, which is non-dissociable in aqueous solution, also comes in this category.

Various authors have worked with ether and chloroform, although few have done anything with carbon disulphide. Townsend (**12**) in his experiments with *Avena* seeds found that if dormant seeds were exposed to a moist concentrated atmosphere of ether for a short time, or to a weaker atmosphere of ether for a longer period, the seeds germinated sooner and grew more rapidly than under normal conditions. This acceleration lasts for some time and gradually disappears. In a later paper (**13**) Townsend verified his results with other seeds: *Zea Mays*, *Cucurbita*, *Phaseolus*, etc. He also found that dry seeds, exposed to an atmosphere of HCN gas (**14**), germinated more rapidly than those not exposed although this advantage did not last for any appreciable time. Miss Latham (**15**), working with *Sterigmatocystis nigra*, determined that cultures of the fungus grown on nutrient media and exposed to chloroform vapor, produced a more luxuriant growth with a greater dry weight than similar

cultures unexposed. Furthermore the oxalic acid formation was lower per unit dry weight in the stimulated cultures.

Johannsen (**16**) was the first to discover that exposing dormant buds to an atmosphere impregnated with ether forced the buds to open earlier than normal. Chloroform has the same effect but is more powerful, less being needed to bring about the same result.

No attempt has been made to cover the whole field of the very voluminous literature on this subject. A comprehensive account may be found in Czapek's "Biochemie der Pflanzen," second edition, Vol. 1, page 147 *et seq.*, 1913.

Among the investigators who experimented with carbon disulphide, none used it in gaseous form but either in pure liquid state or in aqueous solution. Sirker (**17**) in Japan found that mulberry bushes, grown in soil previously treated with CS_2, produced more branches, higher plants and more leaves with a greater dry weight for each individual leaf than bushes grown in untreated soil. Koch (**18**) in 1912 found the same thing with other plants. Koch asserts that the carbon disulphide is not used as a carbon source, nor does it act as an insecticide in killing off the harmful lower organisms in the soil, since under such circumstances a larger amount of the CS_2 would be more beneficial. This, however, is not the case, a larger amount of the CS_2 being harmful, and the stimulation takes place only when the compound is added in minute quantities. Fred (**19**) in the same year stated that carbon disulphide added to the soil in dilute solutions stimulated the growth of soil bacteria, the nitrogen-fixing forms in particular, so that the quantity of nitrogen built up into higher compounds was measurably increased over normal. In a later paper Fred (**21**) corroborated his earlier results and concluded that while after treatment with carbon disulphide the soil showed a reduction in the number of microorganisms, it was followed by a great increase and an increase also in the by-products of their action. With relatively strong applications of carbondisulphide to the soil, corn and oats seemed deleteriously affected, while mustard and buckwheat were benefitted, as shown by increase in dry weight. In acid soil, clover is also stimulated.

The experiments described below, which further test the effect of carbon disulphide on plants, were performed in the

Botanical Laboratories of Barnard College, under the supervision of Professor H. M. Richards, for whose advice and assistance the writer is greatly indebted.

In this work, while no attempt was made to cover every type or condition of plant tissues, a number of widely differing kinds of material were employed. The experiments fall into three groups, each of which could profitably be elaborated beyond what was attempted here. These three categories are as given below and will be considered as separate topics in the following discussion.

1. Stimulation of seeds and seedlings.
2. Stimulation of buds.
3. Stimulation of certain fungi.

Carbon disulphide is a clear, practically colorless liquid when pure, very inflammable and volatile. It has a disagreeable odor, especially when impure, because of the decomposition into other sulphur compounds, hydrogen sulphide in particular (see Graham, **20**). It is soluble in all proportions in alcohol, ether, and chloroform, but only slightly soluble in water. The solubility in water, according to Graham, varies inversely as the temperature, as follows:

At	12°–13°	C.	2.0	gms.	CS_2	dissolve	in	1	liter of water.
"	15°–16°	"	1.91	"	"	"	"	1	" " "
"	25°–27°	"	1.68	"	"	"	"	1	" " "
"	30°–33°	"	1.45	"	"	"	"	1	" " "

From these data, it was estimated by interpolation that at 20°–22° C. (average room temperature) about 1.8 gms. CS_2 dissolves in 1 liter of water.

In the following paper, the concentrations of the solutions used were determined in terms of molecular solutions. The molecular weight of carbon disulphide is 76.125, and if 1.8 grams dissolve in 1 liter of water at approximately room temperature, then a saturated aqueous solution is 0.0235 of a molecular solution. More dilute solutions were prepared from this, in fractions varying by 1/2000M. No attempt was made to determine or maintain the exact concentration closer than this, because carbon disulphide is so easily vaporized and a certain amount of that in solution is continually volatilizing out. In cases where the experiments lasted over a few days, the solutions were renewed at intervals of two or three days.

1. STIMULATION OF SEEDS AND SEEDLINGS

The first phase taken up was to determine if there was any stimulation of young seedlings by dilute solutions of carbon disulphide. Townsend (**12**, **13**, **14**) tested the effect of ether vapor and hydrogen cyanide gas on different kinds of seeds, by soaking seeds in water for twenty-four hours and then putting in an airtight damp chamber containing ether vapor. The exposed seeds germinated more quickly than unexposed controls, but whether left in ether chamber or removed immediately after germination, the stimulated seedlings soon lost their advantage, and five days after germination the control seeds equaled the stimulated in growth. Likewise dry seeds exposed to HCN gas for a short time and then soaked in water germinated more rapidly than seeds not treated with the hydrogen cyanide. However in every case, growth was equal after a week.

In the following experiments, wheat grains (*Triticum sativum*) were used. One hundred grains were soaked in the CS_2 solution for twenty-four hours. Seed pans were filled with moist sphagnum, covered with damp cheese cloth, and grains planted out on top of this. They were then covered with a second layer of cheese cloth, with a pad of moist sphagnum on top of the whole. Pans were kept under a shelf in the greenhouse for three or four days, taking care not to allow the sphagnum to dry out. The seedlings were then uncovered, epicotyls measured and the average taken of those germinated. It was found that the saturated solution completely inhibited growth, while the seedlings in the other solutions grew as shown in TABLE I.

TABLE I

AVERAGE GROWTH IN MILLIMETERS OF EPICOTYLS OF WHEAT SEEDLINGS AFTER BEING SOAKED IN FOLLOWING CS_2 SOLUTIONS FOR 24 HOURS AND LEFT TO GERMINATE FOR 3 OR 4 DAYS

SERIES I. Germinated 4 days

Exp.	A.	B.	C.	Average	Avg. per day
M/2,000			37.7	37.7	9.4
M/4,000	39.7	35.2	38.5	37.8	9.4
M/6,000	40.6	29.2		34.9	8.7
M/8,000	34.8	31.1	41.3	39.1	9.8
M/12,000	38.3	34.1		36.2	9.1
M/16,000	42.7	33.2	37.6	37.8	9.5
M/22,000	41.2	28.9	43.4	37.8	9.5
M/32,000	40.0	36.6	39.4	38.7	9.7
M/40,000			41.5	41.5	10.4
Control	35.8	33.0	36.6	35.1	8.8

TABLE I (*con.*)

SERIES II. Germinated 3 days

Exp.	D.	E.	Average	Avg. per day
M/2,000	13.6	10.0	11.8	3.9
M/4,000	13.3	13.8	13.6	4.5
M/8,000	16.8	14.5	15.7	5.2
M/16,000	14.7	13.7	14.2	4.7
M/22,000	14.9	14.2	14.6	4.9
M/32,000	18.7	14.4	16.6	5.5
M/40,000	12.7	15.3	14.0	4.7
Control	11.1	13.6	13.3	4.4

Although these results show some irregularities due to the comparatively small number of cases, they also reveal a marked stimulation of growth especially in the solutions between M/22,000 and M/40,000 in CS_2 content. The stimulation in the three day experiments is proportionally greater than in the four day instances, showing that the stimulation tends to diminish, and growth tends to approach the normal after an interval, just as Townsend found.

An experiment with *Vicia Faba* seedlings was carried out in the following manner. The seeds were planted and allowed to germinate until the hypocotyls reached a convenient length to measure. A number 400 cc. bottles were almost filled with Knop's nutrient solution and enough CS_2 solution was added to make of desired concentration. The bottles were then fitted with corks, each cork having three holes bored in it, which were just small enough to prevent the seeds from falling through. The seedlings grown as above, were then washed in distilled water, hypocotylsm easured, and arranged in culture bottles so that seed rested on top of cork and hypocotyl extended through the hole into the solution. The bottles were placed in a dark chamber in the green house (temperature varying from 18° to 25° C.), the hypocotyls were measured every twenty-four hours and the daily growth computed.

TABLE II

AVERAGE GROWTH IN MILLIMETERS OF THREE HYPOCOTYLS OF *Vicia Faba* SEEDLINGS, PLACED IN NUTRIENT SOLUTIONS CONTAINING CS_2 TO MAKE OF FOLLOWING CONCENTRATION, EACH EXPERIMENT COMPRISING TWELVE SEEDLINGS

	M/2,000	M/4,000	M/6,000	M/8,000	M/20,000	M/40,000	Control
Exp. A.							
1st day	5.3	6.5	13.0		13.7		7.0
2nd "	2.2	5.4	11.7		16.1		9.5
Total	7.5	11.9	24.7		29.8		16.5
Avg.	3.8	6.0	12.4		14.9		8.3
Exp. B.							
1st day		18.2	18.2	22.7	22.9	17.8	18.9
2nd "		19.4	23.4	21.6	21.0	16.2	19.6
3rd "		21.4	19.0	19.7	15.8	8.1	14.4
4th "		19.2	19.2	23.5	17.0	17.7	16.3
Total		78.2	79.8	87.5	76.7	59.8	69.2
Avg.		19.6	20.0	21.9	19.2	15.0	17.3
Exp. C.							
1st day	16.6	14.6	13.6	13.7	14.7	16.6	19.3
2nd "	10.5	16.0	18.7	21.8	21.6	16.0	17.5
3rd "	14.1	18.4	18.0	29.0	26.7	15.5	19.7
Total	41.2	49.0	50.3	64.5	63.0	48.1	56.5
Avg.	13.7	16.3	16.8	21.5	21.0	16.0	18.8
Exp. D.							
1st day	9.5	16.8	10.8	20.0	39.0	1.5	19.8
2nd "	7.0	11.5	11.0	18.0	12.5	11.0	16.5
3rd "	8.0	14.0	12.9	24.5	18.5	13.2	17.0
Total	24.5	42.3	34.7	62.5	70.0	25.7	53.3
Avg.	8.2	14.1	11.6	20.8	23.3	8.6	17.8
Total average of the four experiments (i.e. twelve examples).							
	8.6	14.0	15.2	21.4	19.6	13.2	15.6

TABLE II shows a distinct stimulation in the growth of hypocotyls of *Vicia* seedlings, in the M/6,000 to M/20,000 CS_2 solutions, the average greatest stimulation being in the M/8,000 dilution, although the M/20,000 shows a greater acceleration in some instances. In the M/40,000 concentration, the CS_2 content has become so dilute that it no longer has any effect on growth. In the higher concentrations, the M/6,000 solution caused a marked stimulation in Exp. A and B, although in other cases

growth is not as great as normal in these dilutions. Although the M/4,000 and M/2,000 solutions do not entirely inhibit growth, they do retard it below normal. Complete inhibition was found in the saturated CS_2 solution, but no dilutions were tried between that and the above.

Koch (**18**) tried similar experiments with *Helianthus annuus* and *Cucurbita Pepo* seeds, letting the seeds germinate and then placing them in the dark, with their hypocotyls in solutions containing 0.1 and 0.05 cc. CS_2 to 1000 cc. water for thirteen to fourteen hours. In one case only, in the solution containing 0.05 cc. CS2 to the liter(about M/150 solution), did he obtain growth higher than normal. This being only a single instance was probably an accident due to the solution being weaker than intended and cannot in any sense be called a stimulation. Koch did not try any solutions weaker than this and therefore did not reach the stimulatory region but really only determined that carbon disulphide acted as an inhibitory agent.

2. STIMULATION OF DORMANT TWIGS

Johannsen (**16**), investigating the effect of ether on dormant twigs, found that they were stimulated so that the buds opened sooner and developed more rapidly when exposed to ether vapor for twenty-four to forty-eight hours, than when unexposed. When using chloroform a much smaller amount was necessary to produce the same result (9 grams of chloroform giving the same acceleration as 40 grams of ether).

With these results in view, experiments were carried out to see if vaporized carbon disulphide would stimulate buds to open. Willow twigs were cut from trees outdoors which had been subjected to winter conditions and were probably frozen in spite of the general mildness of the winter. The lower three or four inches of the stem were placed in a bottle of water and a large bell-jar put over them. Pieces of filter paper, moistened with 10 cc. of carbon disulphide were quickly inserted under the bell-jar. The whole was placed in a pan of water making a water seal so that the carbon disulphide, which vaporizes almost immediately, could not escape from the bell-jar. The twigs were left in this atmosphere (approximately saturated with CS_2 gas) for periods ranging from ten minutes to eighteen hours. They were then removed, the stems were put into fresh water and with a control placed in the greenhouse.

The results of a number of experiments can be summarized as follows. After three days, the twigs exposed ten and twenty minutes began to develop, the buds showing patches of green at the tips. After seven days, the buds on the twigs exposed thirty minutes were open considerably. One of the hour experiments showed slight greening of the upper buds but other specimens gave no evidence of development. After nine days, the control (not exposed to CS_2 at all) had two buds developing. Twigs exposed ten, twenty and thirty minutes continued to show better bud development for two to three weeks longer, after which the condition of all tended to become the same. Twigs exposed for one and a half hours or for two hours started to open but after a day or so became brown and withered, while those exposed for four hours or more showed no signs of development at any time, indicating that the protoplasm itself must have been killed.

3. STIMULATION OF CERTAIN FUNGI

As stated above, there has been a vast amount of work done on stimulation of fungi by metallic salts and other chemicals. Because of this, a number of experiments were set up to test the effect of carbon disulphide on fungi.

To determine the effect of dilute solutions of carbon disulphide on the germination of spores of *Rhizopus nigricans* and *Sterigmatocystis nigra*, hanging drop slides were used. Small glass rings were attached to microscope slides by means of a solution of dextrin in water (vaseline is not practicable since carbon disulphide is very soluble in it). The medium used for the germination of the spores was prepared according to the following formula (see Richards, **4**):

Potassium pho phate	0.5 gm.
Magnesium sulphate	0.25 gm.
Ammonium nitrate	1.0 gm.
Ferrous sulphate	trace
Sugar	5.0 gms.
Distilled water	100 cc.

To this was added 5 gms. of gelatine, and the mixture was then heated in water bath. When the gelatine was completely solved, the medium was filtered tubed (10 cc. to the tube) and sterilized. Before the gelatine hardened, the CS_2 solution was added to make of desired concentration.

A small drop of this gelatine was put on a clean cover glass and inoculated with fungus spores. After inverting the cover glass, and sealing on to the glass ring the slides were left standing at room temperature under a bell-jar containing moist filter paper to prevent slides from drying up. After some hours, slides were examined microscopically for germination, and where possible the germination-tubes were measured by means of a standardized micrometer eye-piece.

According to TABLE III. solutions of carbon disulphide in nutrient gelatine varying from M/16,000 to M/40,000 in concentration, stimulate spores of *Rhizopus nigricans* and *Sterigmatocystis nigra* to germinate sooner than in the same media but without the CS_2. The point of greatest stimulation lies between the M/32,000 and the M/40,000 solutions.

In another type of experiment with *Sterigmatocystis* spores, the stimulation of growth was measured by the increase in dry

TABLE III

AVERAGE GROWTH IN MICRONS OF 10 GERMINATION TUBES OF FUNGOUS SPORES, INOCULATED ON NUTRIENT MEDIA TO WHICH CS_2 HAD BEEN ADDED

RHIZOPUS NIGRICANS

No. of hours	M/800	M/8,000	M/16,000	M/22,000	M/32,000	M/40,000	Control
Exp. A.							
24	10.6	11.9	59.9	over 300	over 300	over 300	250.
Exp. B.							
13½	no	no	no	no	6.7	52.6	no
15	no	no	no	13.9	16.4	83.2	no
18	5.0	no	no	70.0	50.4	over 300	45.9
20½	26.9	no	9.5	103.9	76.7	over 300	59.5
Exp. C.							
13	29.7	57.4	over 300	139.2	over 300	over 300	no
14	59.6	over 300	over 300	over 300	over 300	over 300	no
17	over 300	" "	" "	" "	" "	" "	98.6
Exp. D.							
13	129.6	203.6	——	13.2	8.1	10.1	no
15	281.1	313.0	——	22.7	24.1	46.5	14.8
18	over 300	over 300	——	44.3	73.6	79.3	44.5
Exp. E.							
14	67.5	68.3	——	20.4	39.2	21.0	10.9
17	101.6	148.1	——	62.2	84.3	43.4	25.5
19	127.4	over 300	——	91.6	96.9	88.2	52.6

TABLE III (*con.*)

STERIGMATOCYSTIS NIGRA

No. of hours	M/800	M/8,000	M/16,000	M/22,000	M/32,000	M/40,000	Control
Exp. A.							
29½	44.5	over 300	50.7	——	56.5	20.4	no
48	126.2	" "	over 300	——	over 300	over 300	224.9
Exp. B.							
15	no	no	no	no	no	6.4	no
20	no	no	no	no	no	75.6	no
35	no	no	no	no	no	over 300	no
65	no	—	over 300	over 300	over 300	" "	start
Exp. C.							
19	no	no	no	no	117.0	124.9	no
25	no	no	no	137.5	over 300	over 300	no
27	no	no	no	over 300	" "	" "	no
68	no	no	no	" "	" "	" "	no
91	no	no	over 300	" "	" "	" "	start
Exp. D.							
19	no	no	78.4	57.1	over 300	152.3	no
25	no	no	over 300	over 300	" "	over 300	no
74	no	no	" "	" "	" "	" "	start

weight of the germinating hyphae. In their experiments 150cc. Erlenmeyer flasks were used as culture bottles and, with pipettes and other apparatus, were cleansed with cleaning solution, rinsed in tap water a number of times, then in distilled water and finally in double distilled water. The same solution as in the former experiment, but without the gelatine and with double distilled water was employed as a culture medium. The trace of ferrous sulphate was introduced by adding one drop of a saturated solution of ferrous sulphate in double distilled water.

After the nutrient solution was made up, it was inoculated in bulk with the *Sterigmatocystis* spores, and 50 cc. of the inoculated solution pipetted into each flask. The aqueous CS_2 solution (also prepared with double distilled water) was added last. The flasks were then corked by means of a mercury air trap, which would allow air to come into the flask, but would not allow any gas to escape from the flask and thus change the CS_2 ratio.

After being stoppered, the flasks were left in a dark chamber at room temperature and, as a preventive measure, the controls were put in a different compartment from those to which carbon disulphide had been added. After five days, the flasks were removed, pads filtered off on weighed filter paper and dried in hot air oven at 70° to dry weight. No attempt was made to determine the CO_2 or acid production, although this would have been an interesting point to investigate.

Although growth was not wholly normal in the controls, presumably due to lack of adequate circulation which may have caused carbon dioxide to accumulate, nevertheless the gross appearance of the stimulated was strikingly different from that of control specimens. The solutions containing CS_2 in the most optimum concentrations bore tough pads, thicker and considerably heavier than normal. All the stimulated pads were wrinkled and curled, and slightly yellow on the under surface. Practically no spores were produced, although in some cases a few yellow sporangia were observed. The control felts on the other hand were thin and tender in texture, and more or less covered with black spores. However, if further experiments were to be carried out, a more perfect system of maintaining the concentration of CS_2 in the flasks would have to be devised in order to obtain absolutely normal controls.

TABLE IV

DRY WEIGHT IN MILLIGRAMS OF CULTURES OF STERIGMATOCYSTIS NIGRA, GROWN IN NUTRIENT SOLUTION TO WHICH CS_2 HAD BEEN ADDED

Exp.	Control. No CS_2	M/80,000	M/40,000	M/20,000	M/10,000	M/5,000
A	439	838	800	740	585	270
B	442	1028	815	748	675	370
C	530	765	1035	495	490	—
D	578	788	740	810	540	—
Avg.	497	855	848	698	573	320

The results of TABLE IV are sufficient to indicate that there is a marked stimulation in cultures to which carbon disulphide has been added. The region of greatest stimulation is in the flasks M/80,000 and M/40,000 CS_2 solutions, the more dilute concentration being slightly more advantageous than the other.

Complete inhibition was not found in any of the experiments tried, although the flasks containing M/5,000 solution only produced felts of approximately three-fourths of the normal weight. In some instances the M/10,000 acted slightly as an inhibitor so that growth below normal was produced.

SUMMARY

All things considered, the results of this investigation lead one to conclude that carbon disulphide acts on plants as many other chemical stimulants do. When applied either in aqueous solution or in vaporized condition it inhibits growth, if given in too concentrated a solution or if vapor is used for too long a time.

When used in dilute amounts, carbon disulphide has the ability to stimulate:

(1) Dormant protoplasm, as in the case where twigs exposed to CS_2 vapor for a short period of time quickly resumed their growth;

(2) Active protoplasm, as in case where the hypocotyls of *Vicia* seedlings elongated more rapidly upon the addition of small amounts of CS_2;

(3) Conidial spores of certain fungi which germinated sooner and produced germination tubes elongating more rapidly, the stimulation causing also causes an increase in dry weight.

Carbon disulphide acts also as other stimulants do, in that the acceleration of growth lasts only for a certain period of time, and then growth tends to reach normal again. This fact was shown in the twig experiments and those with *Triticum* grains. The same would probably be true of the other experiments if left running for a sufficient length of time.

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INDEX TO AMERICAN BOTANICAL LITERATURE
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The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to foresty, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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